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Impacts to DHCCP Cost, Schedule and Delivery due to NMFS Proposal for a Phased Construction of North Delta Intake Facilities

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Purpose

The purpose of this White Paper is to evaluate the impacts of phasing the construction of the proposed North Delta Intake facilities as proposed by National Marine and Fisheries Services (NMFS) and discussed at the BDCP State/Federal/Inter-Agency Principals meeting held on July 27, 2011 (see Appendix A: Phasing of North Delta Facilities). The NMFS issue paper states that, "The best available science on impacts to salmonids from large screened diversions (GCID studies) indicates that there could be a large cumulative impact to salmonid survival through the diversion reach with 5 large diversions in operation." The NFMS paper then proposes phased construction of intakes as a key element in reducing the uncertainty around this issue and improving the overall likelihood of a viable project. This report evaluates the impacts of phased construction of the intakes on the construction schedule and cost of the Pipeline/Tunnel Option (PTO). The analysis performed in this report however, is not an optimization of a phased construction approach.

Introduction

DHCCP is considering several conveyance options to transfer water from the north Delta to the state and federal export facilities located in the southern Delta. However, for this paper, only the Pipeline/Tunnel Option (PTO) will be considered for evaluating the impacts of proposed construction phasing. The PTO proposes a new isolated conveyance for diverting Sacramento River water through five screened intakes located between Freeport and Walnut Grove. The diverted water will be conveyed to an Intermediate Forebay (IF) via tunnels and pipes. Water collected in the IF would flow by a combination of gravity and/or pumping through two tunnels to a new forebay, the Byron Tract Forebay (BTF), located adjacent to and south of the existing Clifton Court

Forebay (CCF). Water would then be conveyed to the existing pumping plants serving the State Water Project and Central Valley Project.

The proposed number of intakes and their diversion capacities were based upon the recommendations of the Fish Facility Technical Team (2008), in order to minimize the impacts to fish species that use the river reach for migration and habitat purposes. The north Delta intake facilities are unique facilities as compared to other existing intake facilities due to their size type, and location (tidally influenced river reach). Additionally, the proposed intakes are located along the sole migrating path of the juvenile salmon. The proposed river reach is also the habitat of the delta smelt, another protected species. Because of these reasons, the intakes are proposed to be designed using the best available science so that the operation of the intakes will have the least impacts on these fish species.

Because of the unique nature and use of the river reach by juvenile salmons and delta smelt, the NMFS is proposing phased construction of the five intakes. The construction of two intakes in the first phase will be followed by about three years of studies to examine the impacts of the intakes on fish species. The construction of the remaining three intakes will be decided based upon the performance of the two intakes that are already in operation. The findings from the studies can also be used to improve the design and performance of the remaining three intakes.

The phasing of the intakes will impact the DHCCP in a variety of ways. This white paper considers the impacts of the phasing on construction schedule, construction cost and water delivery. The impacts presented in this paper are based on the conceptual engineering reports (CER), cost estimates, schedules, and operation studies prepared by the DHCCP consultants.

Construction Phasing Scenarios

For the purpose of this impact analyses, the construction phasing proposed by the NMFS paper along with the initial construction scenarios proposed for the DHCCP are categorized into five cases as described below:

Case 1:

Case 1 is the baseline construction schedule. The Case 1 construction schedule would involve construction of all the facilities in one phase as proposed in the CER. The facilities are comprised of five intake structures and pumping plants, pipelines and tunnels that connect the intakes to the IF, two large diameter (33-ft inside diameter) tunnels that connect IF to BTF, an intermediate pumping plant, IF and BTF. The two main tunnels that connect the IF to BTF would be constructed concurrently.

Case 2:

This case would involve construction of facilities in two phases as proposed by the NMFS. Under Phase 1, two intakes and pumping plants, IF, pipelines and tunnels that connect the two intakes to the IF, two main tunnels that connect IF to BTF, and BTF would be constructed.

The completion of the Phase 1 would be followed by the operation and performance monitoring of the two intakes constructed. Following the performance monitoring of the two intakes from Phase 1, the other three intakes and pumping plants, and an intermediate pumping plant would be constructed as Phase 2. Case 2 assumes that Phase 2 construction would not require significant design changes.

Case 3:
This case would be identical to Case 2 except that the Phase 2 construction would require design changes and/or changes in the location of the remaining three intake structures.

Case 4:
This case would be limited to the construction of Phase 1 as proposed by the NMFS paper and as described under Case 2. Case 4 assumes that the performance monitoring of the two intakes constructed under Phase 1 would not allow the construction of the other three intakes and associated facilities.

The impacts from phased construction of north Delta intake facilities on the DHCCP construction schedule, project cost and water supply reliability are discussed below.

(The NMFS proposal also discusses possible variations to the phased approach. One variation would be to build three intakes in Phase 1 but only operate two intakes. The third intake would be built on the backside of the levee but not activated. This alternative has not been considered in this analysis because the impacts of this option will be similar to that of Case 2. The only difference would be in the additional cost of constructing another intake facility. Also a two-dimensional hydraulic modeling study of the Sacramento showed that widening the channel and constructing intakes on the widened areas create zones of slow moving water and pockets of reverse flows. The areas where the water is moving slowly are prone to sediment deposition and will require frequent dredging. Also, the areas with reverse velocity will provide habitat for predator fish.)

Construction Time Impacts

Construction times for various components were compiled from the May 2010 ICF East Schedule (for intakes, intake pumping plants, intermediate pumping plant, and Byron Tract forebay), the November 2009 PTO Schedule (for intake pipe connections and intermediate forebay), and Appendix J of the Tunnel Optimization document (for tunneling). The following are some of the impacts of the phasing on construction duration:

- The total construction times for the four phasing scenarios ranged between 7.25 and 20.5 years (Figure 1).
- Case 1, the Baseline Construction Schedule, assuming that facilities would be constructed in one phase, has the shortest total construction time of 7.25 years, with the intakes and intake pumping plants controlling the construction time (Figure 2).
- Case 2 would need about 17.5 years to complete construction. The 17.5 years include 3 years of study time after Phase 1 construction. Construction times are controlled by the intakes and intake pumping plants (Figure 3).
- Case 3 would have the longest construction completion time about 20½ years (Figure 4). Phases 1 and 2 construction times for Case 3 are controlled by the intakes and intake pumping plants. This case assumes about 3 years of study and an additional 3 years for re-design of the intakes after the Phase 1 construction completion.
- Case 4 has a total construction time of 7.25 years, with the intakes and intake pumping plants controlling the construction time, but has 3 years of study time in addition to the construction time, while only a total of two intakes are completed (Figure 5).

Based on the estimated schedules above, the phased construction of north Delta intake facilities would increase the construction completion time for the full capacity DHCCP by about 10.25 to 13.25 years, depending upon the considered scenarios.

The original construction schedule is based upon a number of assumptions, covering various aspects of planning, design, and construction management of engineering projects. Two assumptions that may further impact the construction schedule are related to permitting and land acquisition. In the preparation of the construction schedule, it was assumed that the real estate and right-of-way (ROW) required to begin the construction will be acquired prior to the release of the construction contracts. Similarly the schedules also assumed that all of the required environmental permits and certifications will be available before the start of the project construction. If relocations and/or redesign of one or more intakes are needed in the phased construction, then it may trigger the need for additional permits, ROW and land acquisition that may prolong the schedule beyond the 20½ years estimated for Case 3.

Cost Impacts

The construction costs discussed below are based on the PTO 2010 Cost Estimates. To account for different years of construction, costs were analyzed in 2011 dollars. The key assumptions used in evaluating the cost impacts are:

- A rate of cost escalation of 5% (per Budget Letter BL 10-15 from the California Department of Finance) was assumed.
- Phase 1 construction for all scenarios was assumed to start in the year 2011.
- Contingencies (25% of applicable construction costs), land/ROW costs (15% of applicable construction costs), and management/design costs (18% of construction + contingency+ land/ROW) were added to all phasing scenarios for the whole project or for Phase 1 and Phase 2.
- The phasing scenarios that had construction re-starting after a study and re-design period, Case 2 and Case 3, include additional mobilization/de-mobilization costs (5% of the applicable construction cost) added to the cost.
- The phasing scenarios that had a study period, Case 2, Case 3, and Case 4, include study costs (10% of the Phase 1 construction cost) added to the cost.
- The phasing scenario that had a re-design period, Case 3, includes re-design costs (30% of the Phase 2 construction cost) added to the cost.

Based upon the assumptions listed above, the present worth total construction costs for the four scenarios ranged between $12.068 billion and $14.236 billion in 2011 dollars (Figure 6). If the construction of the DHCCP is to follow the timeline as envisioned in Case 1, the cost to build the full capacity (15,000 cfs) facility would be about $13.294 billion. However, if the proposed phased construction is followed as described in Cases 2 and 3, the construction of a full capacity facility would cost from $13.902 to $14.236 billion, respectively. Based on the above estimates, phased construction of a full capacity DHCCP as proposed in the NMFS paper would increase the construction cost by about $1.66 to $2.55 billion. Also, if the phase 2 cannot be constructed as described in Case 4, a conveyance facility with about 6,000 cfs capacity would cost about $12.068 billion.

The phasing of the major construction project adds another layer of uncertainty to the project cost due to external or global market conditions. External market forces and time (delays) were identified as two of the three main reasons for the three-fold increase in the construction cost of the Bay Bridge from the initial cost estimates (Historical Review of San Francisco- Oakland Bay Bridge East Span Seismic Retrofit Cost Increases, April 2006). Cost escalations due to the proposed phased construction are shown in Figure 6.
The construction of DHCCP will require huge amounts of energy, particularly diesel fuel. The price of fuel is decided by the activities and demands of the global market.

Therefore, phasing of a project of this magnitude needs to consider the global economy and its effects on the price of construction materials, fuel, labor, and availability of qualified contractors.

Water Supply Impact

One of the major goals of the DHCCP is to improve the water supply reliability through an isolated conveyance system.

In order to make estimates of the impacts of the phasing of intake construction on water supply reliability, CalSim study runs covering a study period from 1992 through 2003 were utilized (A. Munever, email). The CalSim result correlates the annualized diversions from the north Delta intakes for incremental installed capacities of 3,000 cfs, 6,000 cfs, 9,000 cfs, 12,000 cfs and 15,000 cfs. The project diversions presented here represent the early long term planning with 2025 hydrology and 2025 Sea Level Rise scenario. The CalSim Model results used here are not optimized for north Delta diversions only. They represent the dual operation of north and south Delta facilities to meet the projected demand.

Figure 7 depicts the impacts to North Delta diversion from phased construction. Major conclusions that were drawn based upon the modeling runs are as follows:

- The total annualized diversion from the north Delta intakes ranged between 2,090 thousand acre foot (TAF) to 2,928 TAF.
- Case 1, the Baseline Construction Schedule, assuming that facilities would be constructed in one phase, will start delivering the full diversion of 2,928 TAF at the end of the construction period, i.e., 7.25 years after the start of construction activities.
- Case 4, assuming that Phase 2 would not be constructed after a study of Phase 1, has the smallest total delivery of 2,090 TAF. With the construction cost of $12.068 billion, this option will have the highest cost per unit of water delivered.
- The two remaining phasing scenarios (i.e., Case 2 and Case 3), delivered 2,928 TAF from the north Delta intakes after 17.5 years and 20.5 years, respectively, from the start of the construction.
- For Cases 2 through 4, the majority of the conveyance components will be constructed in Phase 1. As seen in Table 1, it will take 17.5 and 20.5 years, respectively for Case 2 and 3, to get the full annualized delivery of 2,928 TAF. Along with the repayment and construction cost, the cost of the diverted water will be very expensive for the first 10 and 13 years of the project. If at the end of the study it is decided not to proceed with the second phase of the project, as in Case 4, the unit price of the diverted water will remain expensive throughout the life of the project. Based

upon the annualized capital repayment cost and annual diversion, phasing of intakes will increase the cost of the diverted water.

Table 1: Diversion through North Delta Intakes

Case	Total North Delta Diversion (TAF) at the End of Year		
	7.25 Yr	17.5 Yr	20.5 Yr
Case#1	2,928	2,928	2,928
Case#2	2,090	2,928	2,928
Case#3	2,090	2,090	2,928
Case#4	2,090	2,090	2,090

The delta is vulnerable to regional seismic activities, flooding of the islands, and sea level rise due to climate change. Constructing the north Delta intake facilities in phases will require continued reliance on the export from the South Delta. One of the USGS (Working Group 1999) seismic studies indicates that there is a 70 percent probability that one or more damaging earthquakes of magnitude 6.7 or larger will strike the San Francisco Bay area before the year 2030. The earthquake hazard is expected to spread broadly across the entire Bay region, from the Pacific coast to the Sacramento Delta, not just restricted to those areas closest to the Bay.

Another study (Preliminary Seismic Risk Analysis Associated with Levee Failures in the Sacramento – San Joaquin Delta, 2005) indicates that if severe earthquake damage occurs, causing many Delta levee breaches (say 20, or more), a long period of water export disruption can be expected – on the order of one or two years or more along with major economic impacts. The study results also suggest that the State faces a significant economic risk (several $10s of billions) if an earthquake causes a significant number of levee failures that would lead to major water delivery disruptions. The magnitude of the economic impact would depend on the time of the earthquake, type of water year (dry or wet), and water stored in the reservoirs at the time of the seismic event.

Other Impacts

The other impacts due to the of phasing of intakes include:

- Part of the facility may need to be built earlier with higher capital cost. There is a greater uncertainty on the construction of the Phase 2 components. This is a big risk for the investors.

- A lack of complete connectivity for the project. By the time the second phase of the project is completed, some of the project components constructed during the earlier phase would require major scheduled maintenance or repairs.

- The phased construction will have construction impacts for a prolonged period, especially near the intake locations.

Conclusions

The issue paper prepared by NMFS proposes phased construction of intakes as a key element in reducing the uncertainty around the impact to salmonid survival through the diversion reach with five intakes

Based on the conceptual level construction schedule, the phased intake construction, as outlined in the NMFS paper, would increase the construction duration of the DHCCP conveyance project from 7.25 years to about 17½ - 20½ years for the full capacity (15,000 cfs) DHCCP conveyance facility. The construction duration is longest for Case 3 which assumes re-design of the intakes is required. The phasing of the intakes will also impact the overall cost of the project. The construction cost, based upon the preliminary cost estimates and proposed schedules, would increase from $12.068 billion to $13.29-14.236 billion for a full capacity DHCCP. However, if the three intakes in phase 2 cannot be constructed, as outlined in Case 4, then a partial DHCCP conveyance facility with 6,000 cfs would cost about $12.068 billion.

The phasing will also impact the water supply reliability of the system. The total annualized diversion from the north delta intakes ranged between 2,090 thousand acre foot (TAF) to 2,928 TAF. However, if the scheduled construction of Phase 2 cannot be completed, then the annualized delivery from the north Delta would only be about 2,090 TAF. Risks in relying on the existing South Delta export facilities for a prolonged period and the uncertainty about the Phase 2 construction and the sunk cost of constructing tunnels and other facilities that may not be used if the Phase 2 is not constructed are some of the other factors that need to be considered.

References

California Department of Finance, Budget Letter 10-15: Escalation of Construction Costs for State Funded Capital Outlay Projects, July 2010.

Jack R. Benjamin & Associates, Inc., and Resource Management Associates and Economic Insight, Preliminari Seismic Risk Analysis Associated with Levee Failures in Sacramento-San Joaquin Delta, June 2005.

The Results Group, Historical Review of San Francisco- Oakland Bay Bridge East Span Seismic Retrofit Cost Increases, April 2006.

USGS Working Group on California Earthquake Probabilities, Earthquake Probabilities in the San Francisco Bay Region: 2000 to 2030- A Summary of Findings, 1999.

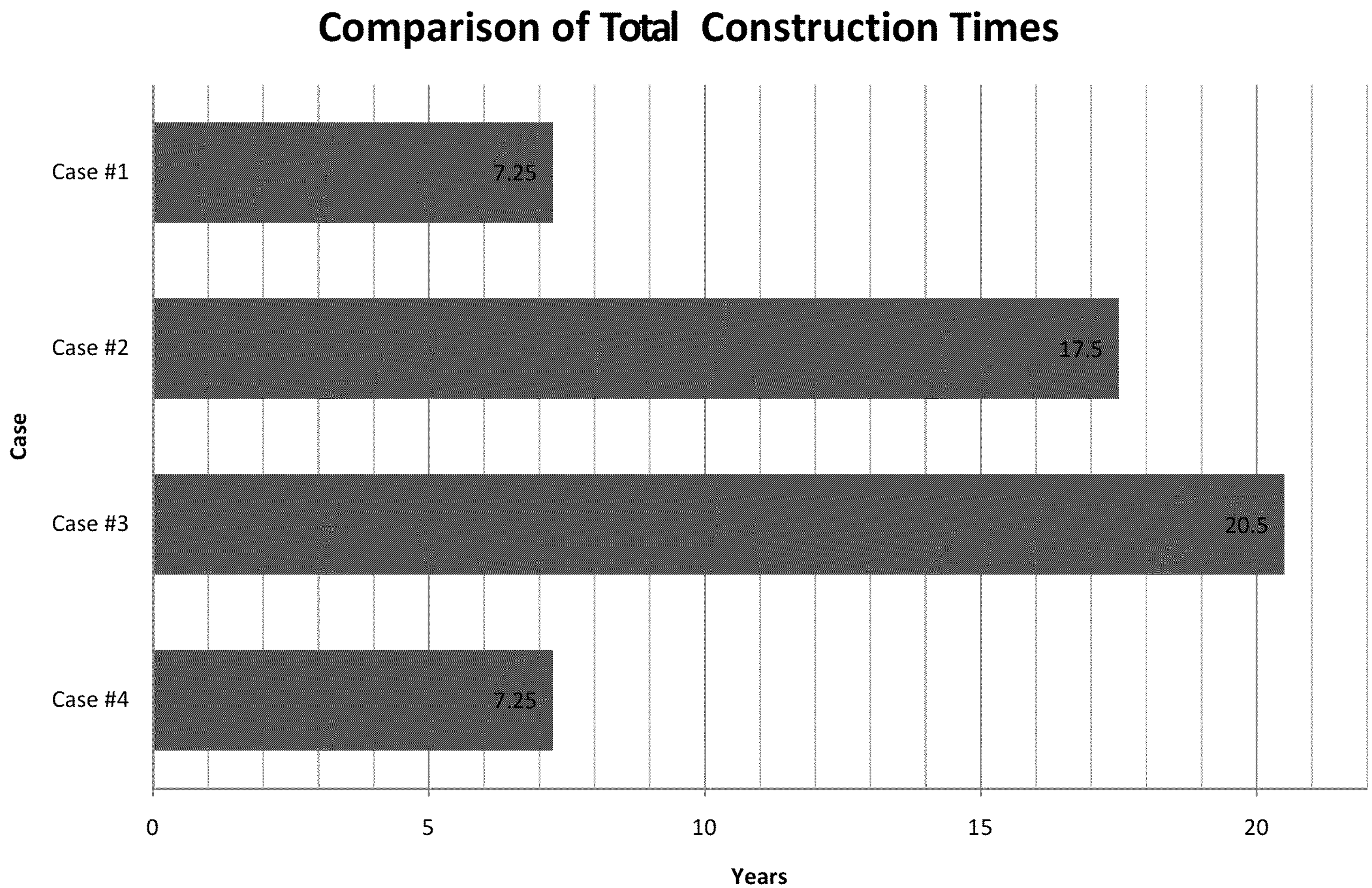

Figure 1: Comparison of Construction Completion Times

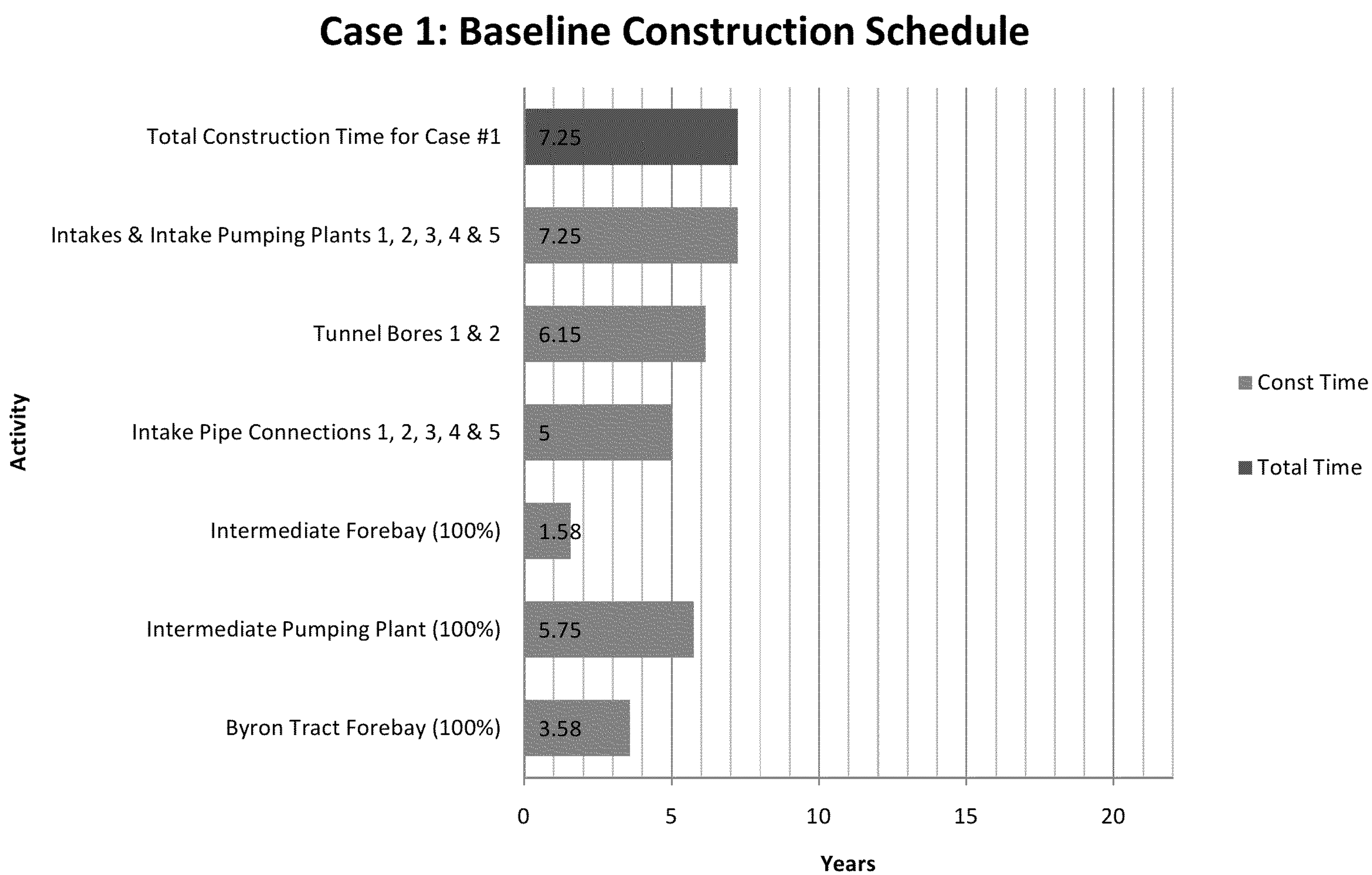

Figure 2: Construction Completion Time for Case 1 (Baseline)

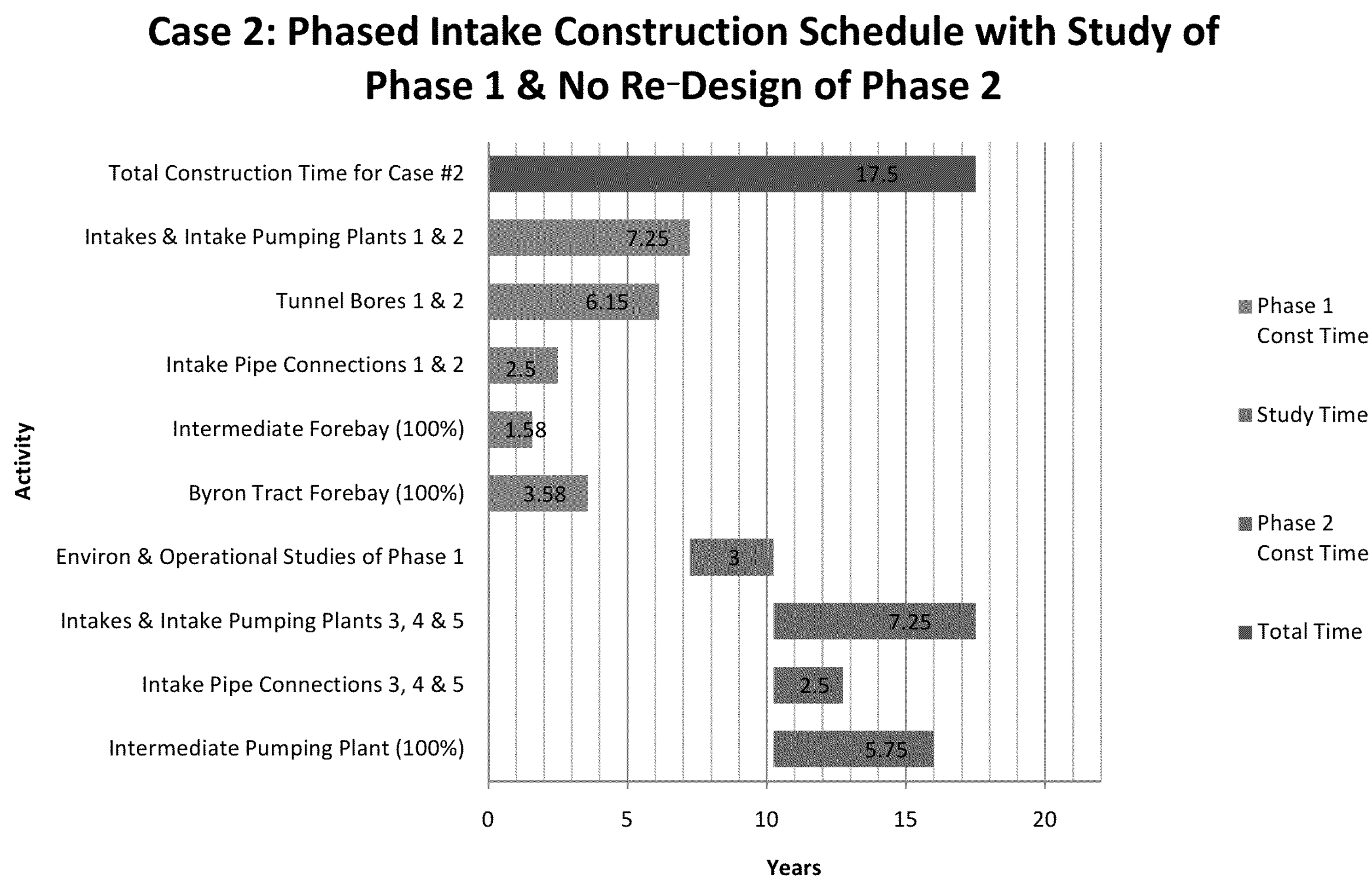

Figure 3: Construction Completion Time for Case 2 (Phase 1 and No-Redesign of Phase 2)

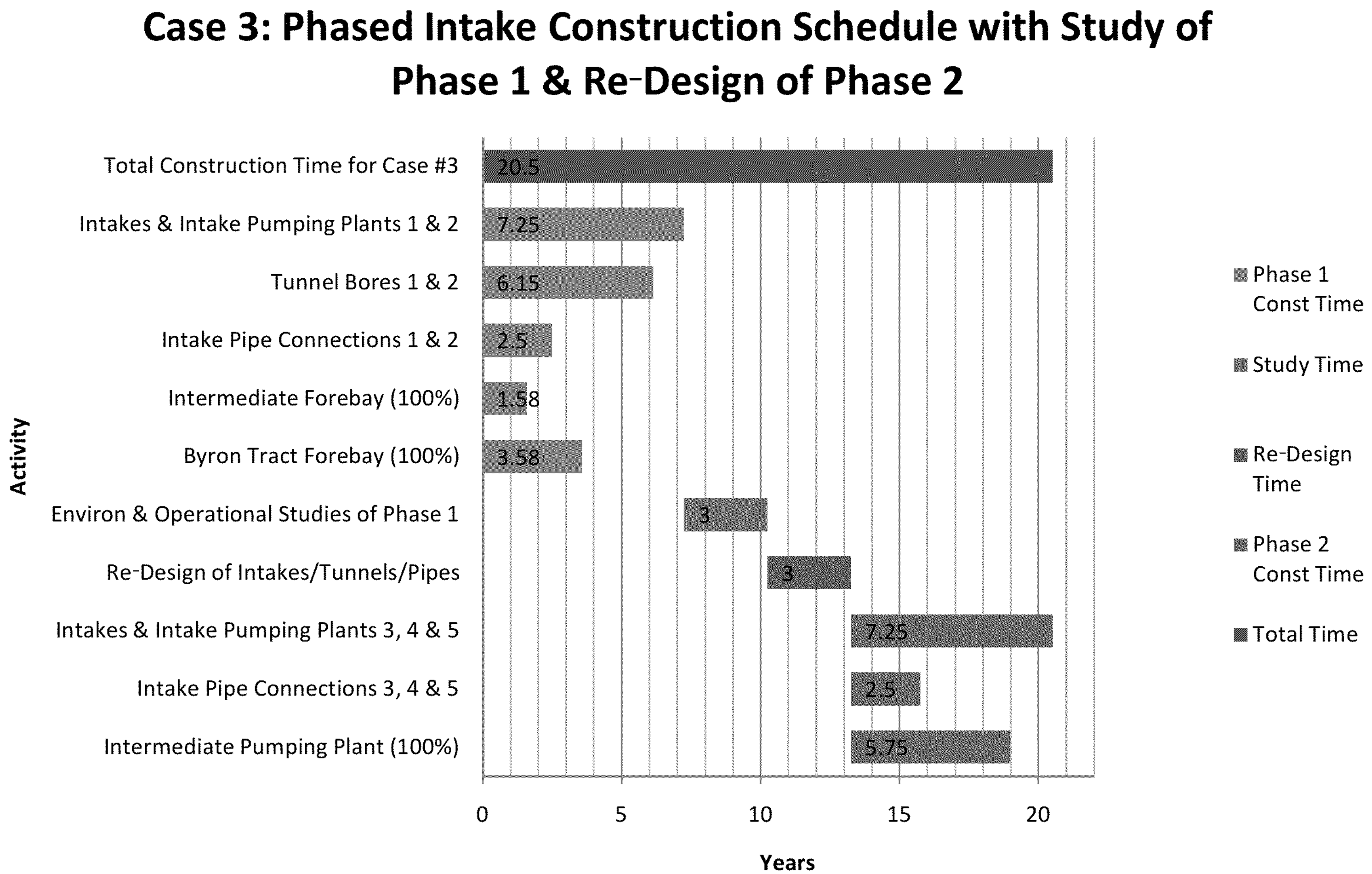

Figure 4: Construction Completion Time for Case 3 (Required Re-design of Phase 2 after the Study Period)

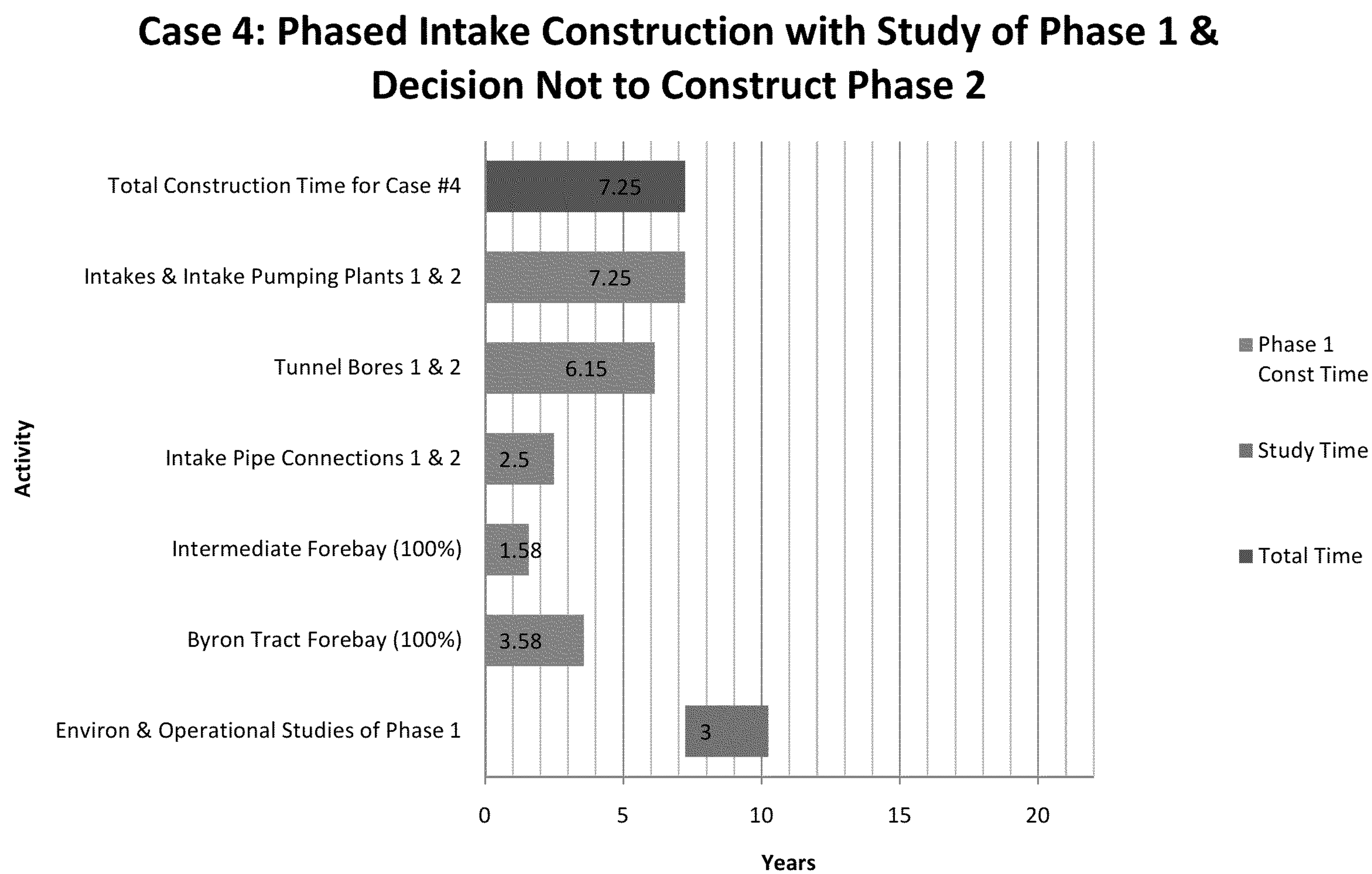

Figure 5: Construction Completion Time for Case 4 (Only Phase 1 Construction and No Phase 2 Construction)

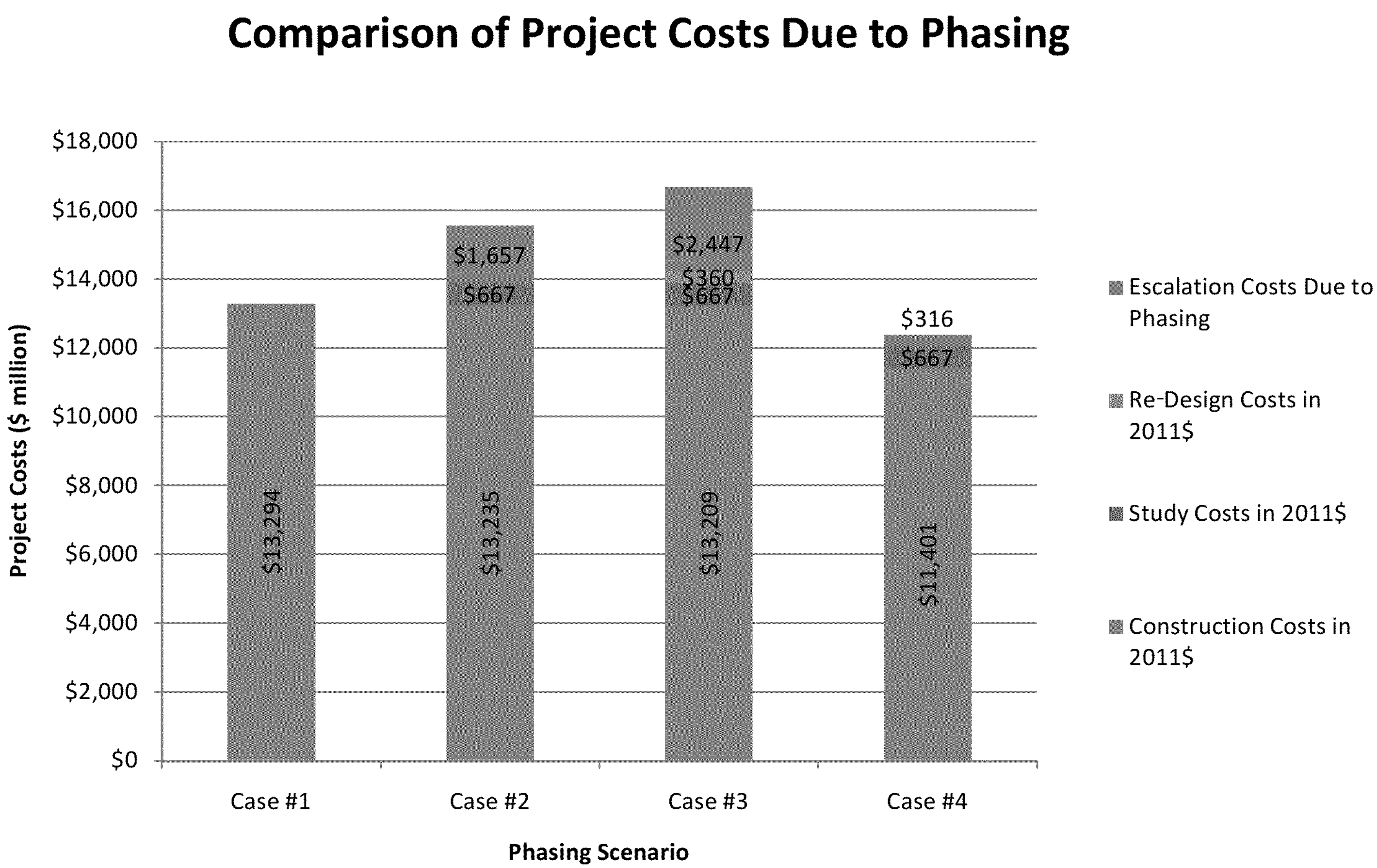

Figure 6: Comparison DHCCP Costs due to Phased Intake Construction

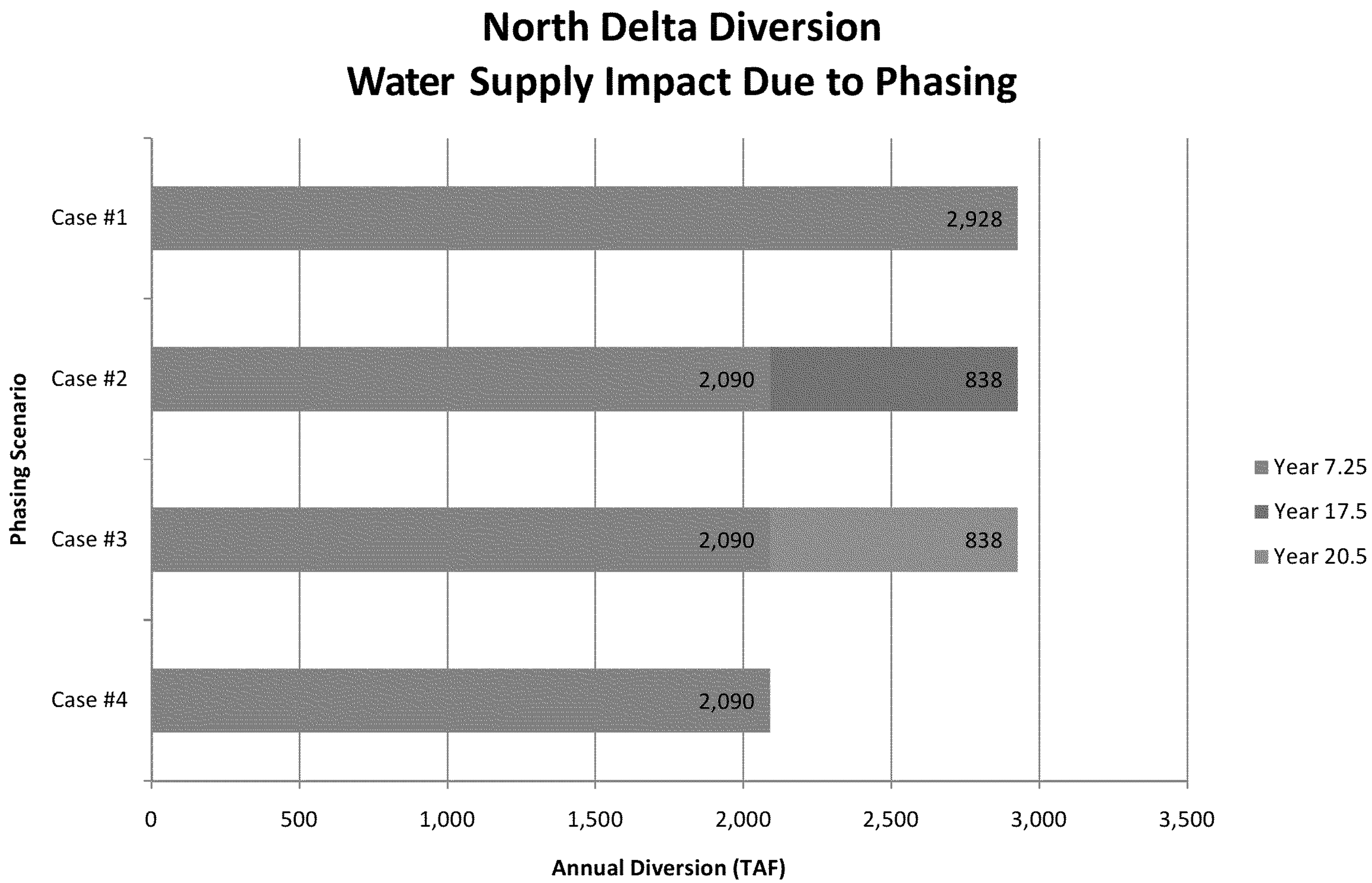

Figure 7: Annualized Diversion from North Delta Intakes from CalSim (Armin 2010)

Appendix A:
Phasing of North Delta Facilities, Issue Paper by NMFS

Phasing of North Delta Facilities

Issue Statement:

What is an acceptable method to reconcile (1) the desire of the applicants to secure complete authorizations for the BDCP program as a whole and (2) the desire of the permitting agencies to remain flexible about the design, engineering and operations of the north delta diversions in order to reduce the considerable uncertainties about how they will perform without requiring multiple staged permitting processes and ESA consultations? Is the use of a proposed "phased" approach to the design, construction and operation of the north diversion facilities as described below an acceptable approach for reconciling these two objectives *for purposes of* shaping an effects analysis and the alternatives for the DEIS?

Relationship to critical path items/effects analysis, and DEIS/DEIR:

The best available science on impacts to salmonids from large screened diversions (GCID studies) indicates that there could be a large cumulative impact to salmonid survival through the diversion reach with 5 large diversions in operation. Related cumulative impacts on delta smelt are uncertain at this time. Phasing of intake construction and operations could be a key mechanism to reduce the uncertainty around the cumulative effects of intake operations and improve the overall likelihood of a viable project.

If the principals agree in concept on phasing, then this concept can be incorporated into ICF's Analytical Framework for the Effects Analysis for alternatives greater than 6,000 cfs North Diversion capacity. The analytic framework can use phasing as a mechanism to address uncertainties. This approach could allow the effects analysis to proceed, consistent with best available science, without identifying a red flag associated with cumulative impacts of screens in this reach. The details of this approach would be worked out in the Analytic Framework during the August agency review period. An analysis of the cumulative effects of intake operations, and how those effects fit into a broader suite of conservation actions with both positive and negative effects on salmonid and delta smelt survival, will be included in the Effects Analysis, in both its component parts and its roll-up.

In general, phasing of north delta pumping capacity would be bracketed by the various capacities included in the alternatives under consideration. However, because construction impacts (both social and environmental) would be stretched out over a longer period of time, the details and structure of the NEPA/CEQA analysis might be different under a phased scenario than under a single construction scenario. How to incorporate phasing into the alternatives and what range of assumptions about performance will satisfy NEPA/CEQA needs more discussion at a technical staff level. These analyses have not yet been completed in the DEIS/DEIR, and incorporating this concept into the analytical process should not slow down the completion of the final draft.

Proposal Overview:

The BDCP permit and consultations would include an assumption of a full build out to total capacity (total capacity will be determined later when a preferred alternative is selected in early 2012), with a two phased approach to constructing the individual intake units based on lessons learned during the first construction phase, testing, monitoring, and adaptive management and subject to meeting cumulative reach survival and other performance criteria.

Basic concepts:

1. Conduct pre-construction studies/monitoring per FFTT recommendations to insure best possible design for initial phase and determine baseline conditions in the diversion reach (predator densities, salmonid survival rates, etc.). The FFTT report lists approximately 10 years of studies. While some of these studies (baseline survival monitoring, refugia optimization, etc.) would likely continue up to, and beyond, operation of the facilities, the intent is to complete the engineering design within the next few years and to have the phase one facilities constructed and ready to operate within 10 years.

2. Construct full size main tunnels and forebay to avoid second mobilization costs.

3. Construct 2 intakes (total 6,000 cfs capacity), supporting pumps and connections to tunnels for the initial phase.

4. Establish specific performance criteria and requirements (*i.e.* NMFS/DFG/FWS screening criteria, predation levels, overall survival through reach, etc.). Salmonid and delta smelt survival criteria to be developed using life-cycle modeling with consideration of overall effects of plan implementation (*e.g.* initial per screen juvenile salmon survival of 98% and cumulative reach survival of 95% as compared to baseline survival rates in the reach).

5. The DEIS alternatives could encompass a wider range of performance assumptions and phasing timing or location assumptions in order to capture a full range of potential outcomes for NEPA/CEQA purposes and preserve the ability for continued analysis through the DEIS to refine approaches.

6. Monitor performance and biological effects of operations of Phase 1 per FFTT recommendations.

7. Develop detailed study designs, including specific results criteria that would indicate the new intakes are meeting performance criteria, and commence construction of second phase once those study results are achieved. The FFFT memo includes a broad range from 3 to 15 years[1] of analysis depending on variability in hydrology. The intent is to narrow this range by developing robust study designs and statistical power analyses.

8. Develop a plan to address catastrophic Delta Island flooding by modifying north Delta pumping operations to meet emergency water supply demands until south Delta pumps are back on line.

9. Regarding intake locations, the goal and default assumption is that the project will determine the location of all intakes (for both Phase 1 and possible Phase 2) no later than

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[1] There is not agreement amongst the five agency Principals on this range; this needs further discussion and refinement.
[2] Principals agreed to have further staff analysis to expand on these "plan B" concepts.

the Final EIS. For now, intakes 6 and 7 will receive full analysis for biological effects, and conceptually be included in one or more alternatives over 6,000 cfs capacity in the DEIS. If analysis shows these intakes locations are expected to provide benefits to covered aquatic species, then they would advance into one or more of the alternatives in the draft EIS/EIR, for further review prior to the final EIS/EIR. At the final EIS/EIR stage, the applicants and lead NEPA/CEQA agencies would make the determination as to whether to include intakes 6 and/or 7 as one or two of the five proposed intake locations, exclude them from further consideration, or maintain then in the analysis as "alternative locations" to be selected through adaptive management during the initial design study period or following completion of phase 1 of the project (*i.e.* all 7 locations would be fully described in the document, and the final determination would be made after phase 1 results are analyzed).

"Plan B" if performance criteria are not met:[2]

10. Intensify studies to determine cause of increased mortality. If cause can be conclusively linked to a structural or other physical "flaw" in intake design or problem with location, correct that flaw or modify location for second phase of intake construction.

11. Use life-cycle analysis to re-examine the initial performance criteria, overall benefits and impacts of implementing the plan, and use adaptive management program, including an independent science review component, to recommend adjustments to improve the plan. Adjustments could be recommended to other conservation measures to offset reach specific survival impacts, or to the performance criteria themselves, or to both. Further construction would depend on the specific findings of the adaptive management program and life cycle analysis.

12. If neither 9 nor 10 above indicate that phase 2 should be built, maintain 6000 cfs capacity and optimize balance between north and south delta exports to meet the co-equal goals of the plan.

Proposal Variant:

As a variant to this proposal, the project could build three intakes in Phase 1, but only operate 2. The third intake would be constructed to the back side of the levee. In-water construction associated with that intake, and any additional intakes would depend on the results of attaining performance criteria during Phase 1, per process above.

Potential Benefits:

1. Improvement in engineering design for second phase by learning from building first phase.

2. Avoidance of unnecessary intake construction by evaluating tradeoffs in operation between north and south Delta pumping to determine proper balance.

3. Greatly reduces the level of instream construction impacts that would result from building all 5 intakes at the same time.

4. Cost-savings by using gravity-flow from the forebay in the north Delta to south Delta pumps as a result of diverting less than 7,000 cfs from the Sacramento River (no need for new pumping station until second phase).

5. During the phasing period, total exports would be greatly improved over baseline conditions while south delta pumping would be greatly reduced. The July 2010 sizing analysis found that 6,000 cfs capacity could provide the same total average exports (north and south combined) as 15,000 cfs capacity under Steering Committee Feb. 2010 operations (6.1 maf), while resulting in approximately 1 million acf reduction in average annual south delta exports as compared to baseline (OCAP RPAs) conditions. These relationships hold under the 2025 climate change scenario and the "increased outflow" scenario included in the July 2010 sizing analysis.